REMARKS

In the last Office Action, claims 1-9 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 4,798,953 to de Chambost ("de Chambost"). The Examiner stated that de Chambost discloses a fine stencil structure correction device having a charged particle beam microscope lens-barrel L_1, L_2, L_3 which may emit a focused ion beam that scans and corrects shape defects in a fine stencil structure sample S using an etching or deposition function (citing col. 1, lines 19-24), transmitted beam detecting means DSC comprised of a beam target for emitting secondary charged particles (citing col. 4, lines 47-51) and a secondary charged particle detector which detects secondary charged particles from the beam target, and an absorbed current detector for measuring the transmitted beam.

By the present response, the specification has been suitably revised to correct informalities and improve the wording. Claims 1-9 have been canceled without prejudice or admission and replaced by new claims 10-37. The newly added claims contain revised versions of the original claims amended in formal respects to improve the wording and place them in better conformance with U.S. practice, and new claims added to obtain a fuller and more comprehensive scope of coverage. Adequate support for the subject matter recited in claims 10-29 may be found in the specification as originally filed.

Applicants respectfully submit that claims 10-37 patentably distinguish over the prior art of record.

Increases in the level of VLSI integration have led to the production of high functioning miniature devices such as portable and handheld computers and mobile telephones. In such devices, circuit patterns are drawn with a few million elements integrated into a semiconductor chip having an overall dimension of a few square millimeters and a line width on the order of nanometers. Development of lithographic technology for implementing this line width has been ongoing.

Thus far, the main focus of lithography research has been optical lithography technology, where the wavelength of light is extremely short to correspond to the fine detail of the pattern. However, the use of optical lithography has encountered problems because optical systems and photoresist have processing limits and cannot achieve a line width beyond a certain minimum value. Accordingly, a great deal of attention has been placed on new technologies that replace light with a source such as an electron beam or ultra-short-wavelength ultra-violet light.

The use of electron beam processing techniques has presented new challenges. For instance, shape defects in electron beam exposure masks are corrected using etching or deposition techniques.

A dimension of the thickness with respect to the width of an ultra-fine stencil structure is a high aspect ratio. As the aspect ratios of such structures increase, defects that are located at deep regions of the structure do not result in the emission of a large number of secondary electrons that easily reach a detector. As a result, a sufficient number electrons are not detected and it is difficult to observe SIM images from the surface direction. Namely, it is difficult for secondary electrons from a deep hole or from the bottom of a deep channel to reach a detector via an opening in the mask surface. Thus, it is difficult to reliably determine the shape of the defect correction portion from a SIM image. Because of this, it is not possible to reliably confirm the finished shape of deep portions. Consequently, fragments of material that should have been removed remain.

Transmission characteristics of ion beams and electron beams differ. Ion beams cause secondary electrons to be ejected from deeper portions of material with a high aspect ratio. However, use of an FIB device for observation of a corrected electron beam exposure mask is difficult. Thus, observation is typically performed using an electron beam device such as a transmission electron microscope (TEM) or scanning electron microscope. However, repeating a cycle of

correction and scanning between these devices is a troublesome procedure in which the sample is extracted from the vacuum chamber of one device and moved to that of another device, the environmental conditions are adjusted, positioning alignment is carried out, and processing and scanning is then implemented. This procedure is not only time consuming, but increases the possibility of new defects being introduced as a result of dirt becoming attached during movement of the sample.

Further, in the case of scanning using an electron beam, it is necessary to observe both a SEM image for observing surface shape and a transmission image corresponding to a projected image. It is therefore necessary for the electron beam to be incident to the mask surface from an orthogonal direction. As a result, it is necessary to incline the sample stage by a substantial angle. Even when an FIB lens barrel and a SEM lens barrel are separated by a large distance so that they do not interfere with each other, it is necessary to move the sample stage substantially in the horizontal direction. Even slight inaccuracy in such movement results in defective devices.

The present invention overcomes the foregoing problems by providing a charged particle beam device capable of not only correcting defects in an electron beam exposure

mask of an ultra-fine stencil structure, but which is also capable of providing a microscopic image of deep defect portions without necessitating sample movement.

The fine stencil structure correction device of the present invention comprises a device for irradiating and scanning a fine stencil structure with a charged particle beam source located on a first side of the fine stencil structure for correcting shape defects in the fine stencil structure using an etching and/or deposition function, and means for detecting a transmitted beam preferably located on a second side of the fine stencil structure opposite the first side. An absorbed current detector or a combination of a transmitted beam target and a secondary charged particle detector are used as the detection means in preferred embodiments.

More specifically, as recited by newly added independent claim 10, the sample correction device comprises a sample stage for supporting thereon a sample, a first charged particle beam lens barrel for emitting a first charged particle beam for scanning across the sample and correcting a shape defect in the sample using an etching or deposition function, and first transmitted beam detecting means for detecting a first transmitted beam comprised of the first charged particle beam penetrating through the sample when the fine sample is supported on the sample stage and is being irradiated by the first charged particle beam. Newly added independent claim 36 contains similar language.

Accordingly, independent claims 10 and 36 require transmitted beam detecting means for detecting a transmitted beam comprised of a charged particle beam penetrating through a sample.

In the embodiment shown in Fig. 1A of the application drawings, the apparatus has a sample stage 30 for fixing and moving a sample mask 3 relative to an focused ion beam (FIB) lens barrel 1, a secondary charged particle detector 4 for detecting secondary charged particles discharged from the sample mask 3 irradiated by the focused ion beam 2, a target for secondary electron generation 6 arranged at the rear side of the sample stage 30 opposite the FIB lens barrel 1 and a secondary charged particle detector 5 for detecting secondary charged particles emitted by the target 6. Further, the sample stage 30 is provided with a hole at a central portion to allow a primary beam to be incident from a vertical direction and detect transmitted particles of the primary beam in a vertical direction, and for carrying out detection of secondary particles.

No corresponding structure is disclosed or suggested by the prior art of record.

De Chambost discloses a microlithography apparatus for projecting the image of an object onto a sample plane using an electron beam. The apparatus has a single continuous insulating tube T1 having an inner metalized surface for

protecting the path of the electron beam. The tube T1 has an axis which coincides with the beam axis. A first lens L1 is arranged around the tube between the object and the sample plane and has an optical center on the axis of the tube T1. A second lens L2 is arranged around the tube T1 and between the first lens L1 and the sample plane for reducing the image of the object. A third lens L3 is arranged around the tube T1 and has an optical center on the axis of the tube T1. The third lens is arranged between the first lens L1 and the sample plane and also reduces the image of the object. The first lens L1 adjusts the image of the object in the optical center of the third lens L3, and the tube T1 extends from the object to the bottom of a pole piece of the third lens.

Although de Chambost discloses a sample stage for supporting a fine stencil structure, and a charged particle beam lens barrel for emitting a charged particle beam for scanning across a sample, the reference fails to disclose or suggest transmitted beam detecting means for detecting a transmitted beam comprised of the charged particle beam penetrating through the sample when the sample is provided on the sample stage and is being irradiated by the charged particle beam.

Accordingly, de Chambost does not anticipate newly added independent claims 10 and 36. See, e.g., Continental Can Co. USA v. Monsanto Co., 20 USPQ2d 1746, 1748 (Fed. Cir.

1991) ("When more than one reference is required to establish unpatentability of the claimed invention anticipation under §102 can not be found"); and Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co., 221 USPQ 481, 485 (Fed. Cir. 1984) (emphasis added) ("Anticipation requires the presence in a single prior art reference disclosure of each and every element of the claimed invention, arranged as in the claim"). Since de Chambost fails to disclose or suggest the claimed transmitted beam detecting means, it does not anticipate the claimed invention.

Nor does de Chambost render obvious any of claims 10-37. A showing of obviousness requires the Examiner to demonstrate that it would have been obvious from a fair reading of the prior art reference as a whole to modify the teachings of the prior art to replicate the claimed invention. De Chambost discloses a charged particle beam apparatus that does not include transmitted beam detecting means as required by the claimed invention. The reference would not have provided any motivation to one of ordinary skill in the art to employ the claimed transmitted beam detecting means. The mere fact that the reference could be so modified would not have made the modification obvious unless the prior art suggested the desirability of the modification. See Carl Schenck, A.G. v. Nortron Corp., 713 F.2d 782, 787, 218 USPQ 698, 702 (Fed.

Cir. 1983); and In re Sernaker, 702 F.2d 989, 995-96, 217 USPQ 1, 6-7 (Fed. Cir. 1983) (both citing In re Imperato, 486 F.2d 585, 587, 179 USPQ 730, 732 (CCPA 1973).

Accordingly, applicants respectfully submit that claims 10-37 patentably distinguish over the prior art of record.

In view of the foregoing amendments and discussion, the application is now believed to be in condition for allowance. Accordingly, favorable reconsideration and allowance of the claims are most respectfully requested.

Respectfully submitted,

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